BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 136 220 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.09.2001 Bulletin 2001/39

(51) Int Cl.[7]: **B29C 45/17**

(21) Application number: **01302395.7**

(22) Date of filing: **15.03.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **16.03.2000 JP 2000073498**

(71) Applicant: **FANUC LTD.**
Minamitsuru-gun, Yamanashi 401-05 (JP)

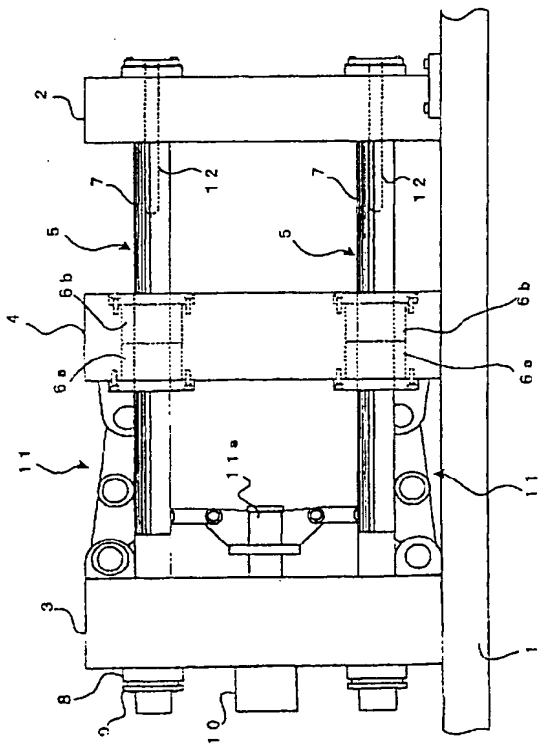
(72) Inventors:
- **Ito, Susumu**
  Hino-shi, Tokyo 191-0065 (JP)
- **Nishimura, Koichi**
  Susono-shi, Shizuoka 401-1115 (JP)

(74) Representative: **Billington, Lawrence Emlyn et al**
Haseltine Lake & Co.,
Imperial House,
15-19 Kingsway
London WC2B 6UD (GB)

(54) Mold clamping mechanism of molding machine

(57) A ball spline nut is provided in each of tie bar penetrating holes formed in a moving platen constituting a mold clamping mechanism of an injection molding machine. On the other hand, a portion of a tie bar one end of which is fixed to a stationary platen, engaging with the tie bar penetrating hole in the moving platen, is made a ball spline shaft. Since there is no clearance between the ball spline shaft and the ball spline nut engaging therewith, in mold clamping and mold releasing processes, the posture of a movable mold attached to the moving platen with respect to a stationary mold attached to the stationary platen is always kept constant.

FIG. 1



EP 1 136 220 A2

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a mold clamping mechanism of a molding machine such as an injection molding machine.

[0002] In a conventional mold clamping mechanism of a molding machine such as an injection molding machine, a stationary platen and a rear platen are usually connected to each other by four tie bars, and a moving platen is disposed between the stationary platen and the rear platen. The moving platen has four tie bar penetrating holes, and a tie bar passes through each of these holes.

[0003] A movable mold is attached to a face of the moving platen, opposed to the stationary platen, and a stationary mold is attached to a face of the stationary platen, opposed to the moving platen. To perform mold clamping or mold releasing, the moving platen is moved toward or away from the stationary platen by a driving source such as an electric motor and a hydraulic cylinder.

[0004] When the moving platen is moved, the tie bars serve as a guide. In the tie bar penetrating hole formed in the moving platen is installed a bush serving as a sliding bearing. The tie bar passes through the bush.

[0005] A problem with the conventional mold clamping mechanism is that if the injection molding machine is used for a long period of time, a clearance or play between the bush installed in the penetrating hole formed in the moving platen and the tie bar increases. As a result, the moving platen guided by the tie bars tilts, so that a face of the movable mold attached to the moving platen and a face of the stationary mold attached to the stationary platen become non-parallel with each other.

[0006] In the mold releasing process, if the face of the movable mold is not parallel with the face of the stationary mold, there occurs a phenomenon such that a part of the face of the movable mold is separated from a part of the face of the stationary mold while other parts of the face of the movable mold remain in contact with other parts of the face of the stationary mold. If such a phenomenon occurs when a high precision part such as a lens is molded by using an injection molding machine, a strain such as a tensile stress is imparted to a molded product, so that a possibility of molding a defective product increases.

[0007] To avoid this phenomenon, a technology has been proposed in which a straight guide is provided on a base frame of the molding machine to guide the moving platen by using the straight guide. The purpose of this technology is to prevent the moving platen from tilting so that the moving platen is kept parallel with the stationary platen.

[0008] However, since the straight guide does not support the upside of the moving platen though supporting and guiding the downside (base dame side) thereof, it cannot restrain a tilt of the upside of the moving platen. Also, although the straight guide can prevent the moving platen from tilting transversely with respect to the travel direction of the moving platen, it has a problem in that it is difficult to prevent a longitudinal tilt.

[0009] An object of the present invention is to provide a mold clamping mechanism of an injection molding machine, in which a face of a movable mold attached to a moving platen is kept parallel with a stationary mold attached to a stationary platen to prevent the moving platen, sliding while being guided by tie bars, from tilting with respect to the tie bars.

[0010] With the above object in mind, in the present invention, a ball spline nut is provided in a tie bar penetrating hole formed in the moving platen, and at least a portion of the tie bar which slides with respect to the moving platen is made a ball spline shaft. In this way engagement of tie bar with the moving platen is made a ball spline connection. Thereby, a clearance or play between the tie bar and the moving platen is eliminated, so that the posture of the moving platen can always be kept constant.

[0011] Also, a hole for inserting a sensor for measuring a strain of the tie bar to make measurement and adjustment of a mold clamping force developed by the tie bar is formed in the tie bar along the axial direction from the end face central portion of the tie bar. The number of the tie bars is four, and two or more of the ball spline nuts are provided for every tie bar, so that a tilt of the moving platen can be prevented more reliably.

[0012] According to the present invention, since the moving platen is not tilted even when it slides while being guided by the tie bars, when the injection molding machine is in a mold releasing process, the whole area of the face of the movable mold attached to the moving platen separates temporarily from the face of the stationary mold attached to the stationary platen. Therefore, a strain such as a tensile stress is not applied to a molded product, so that highly accurate product can be molded.

[0013] For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

accordance with one embodiment of the present invention; and

FIG. 2 is an explanatory view of strain measurement for a tie bar in the embodiment

FIG. 3 shows one example of a ball spline nut employed in the mold damping mechanism shown in FIG. 3.

[0014] An outline of a mold clamping mechanism of an injection molding machine in accordance with one embodiment of the present invention will be described with reference to FIG. 1.

[0015] A stationary platen 2 is fixed on a base frame 1 of an injection molding machine. To the stationary plat-

en 2 is fixed one end of each of four tie bars 5. The other end of the tie bar 5 passes through a rear platen 3 supported on the base frame 1.

[0016] A face of the stationary platen 2, opposed to the rear platen 3, has a square shape, and also a face of the rear platen 3, opposed to the stationary platen 2, has a square shape. One end of each of the four tie bars 5 is fixed at each of four comers of the stationary platen 2, and the other end thereof passes through each of four comers of the rear platen 3. FIG. 1 shows only two of the four tie bars 5.

[0017] One end of the tie bar 5 is fixed to the stationary platen 2 by using fastening means such as a nut, while the other hand, the other end of the tie bar 5 is attached to the rear platen 3 so that the rear platen 3 can move along the tie bar 5 via a mold thickness adjusting nut 8.

[0018] The mold thickness adjusting nut 8 has a pinion 9 fixed thereto. A chain (not shown) is set between the pinions 9 provided on the four tie bars 5, and the four pinions 9 are rotationally driven in synchronism with each other by a mold thickness adjusting drive means (not shown) such as a servomotor, by which the rear platen 3 is moved on the base frame 1 in the axial direction of the tie bar 5. By the movement of the rear platen 3, a distance between the rear platen 3 and the stationary platen 2 is adjusted. As a result, a predetermined mold clamping force at the time of mold clamping can be obtained according to the thickness of a mold used.

[0019] Further, a moving platen 4 is disposed between the stationary platen 2 and the rear platen 3. The moving platen 4 is formed with tie bar penetrating holes at four corners thereof Through each of the tie bar penetrating holes, the tie bar 5 passes.

[0020] Between the rear platen 3 and the moving platen 4, a toggle mechanism 11 is provided. When a cross head 11a of the toggle mechanism 11 is actuated by a driving source 10 such as a servomotor fixed to the rear platen 3, the moving platen 4 moves in such a direction as to go away from or come close to the rear platen 3.

[0021] A stationary mold (not shown) is mounted on a face of the stationary platen 2, opposed to the moving platen 4, while a movable mold (not shown) is mounted on a face of the moving platen 4, opposed to the stationary platen 2, The driving source 10 is driven to actuate the toggle mechanism 11 so that the moving platen 4 is moved along the tie bars 5, by which the opening and closing of the mold (stationary mold and movable mold) and mold clamping are performed.

[0022] The above-described configuration is the same as that of a conventional toggle type mold damping mechanism.

[0023] In the present invention, a ball spline is formed on the tie bar 5 at least in a range in which the moving platen 4 slides, providing a ball spline shaft 7. On the other hand, a pair of ball spline nuts 6a and 6b are provided in the penetrating hole formed in the moving platen 4 through which the tie bar 5 passes. Specifically, in the present invention, in place of the bush (sliding bearing provided in the tie bar penetrating hole, a single or a plurality of ball spline nuts are provided. Further, corresponding to these ball spline nuts, a range engaging with the tie bar penetrating hole in the moving platen 4 of the tie bar 5 is formed into the ball spline shaft 7. In this respect, the mold clamping mechanism in accordance with the present invention differs from the conventional one.

[0024] FIG. 3 shows one example of a ball spline nut employed in the mold clamping mechanism shown in FIG. 1, which comprises an outer cylinder 21, a retainer 22, a ball stopping ring 23 and sealing 24. A spline shaft 25 is inserted into the ball spline nut such that a spline shaft 25 can move in the axial direction of the ball spline nut Reference numeral 26 denotes balls.

[0025] In the embodiment shown in FIG. 1, a pair of ball spline nuts 6a and 6b are provided in the tie bar penetrating hole formed in the moving platen 4. However, the number of ball spline nuts provided in one tie bar penetrating hole is not limited to two, and one or three (or more than three) ball spline nuts may be provided. If the number of ball spline nuts is increased, the length engaging with the ball spline shaft 7 increases, so that a tilt of the moving platen 4 can be prevented more securely. As a result, the posture of the movable mold attached to the moving platen 4 with respect to the stationary mold attached to the stationary platen 2 is kept constant more reliably.

[0026] Thus, to slide the moving platen 4 along the tie bars 5, a single or a plurality of ball spline nuts are provided in the tie bar penetrating hole formed in the moving platen 4, and also a ball spline is formed on the tie bar 5 at least in a range where the tie bar is engaged with the tie bar penetrating hole in the moving platen 4 to provide a ball spline shaft 7. A ball (not shown) engages with a ball rolling groove of this spline, and a preload is given to the ball Therefore, between the ball spline shaft 7 and the ball spline nut 6a, 6b engaging there with (therefore, between the tie bar 5 and the moving platen 4), a clearance (play) scarcely occurs. Moreover, since the tie bar 5 passes through the moving platen 4 at four corners thereof the moving platen 4 does not tilt longitudinally and transversely with respect to the travel direction of the moving platen 4 (the axial direction of the tie bar 5).

[0027] Thereupon, even if the moving platen 4 moves along the tie bars 5 and lies at any position, the posture of the moving platen 4 with respect to the stationary platen 2 is always kept constant. Specifically, the face of the movable mold attached to the moving platen 4 is kept parallel with face of the stationary mold attached to the stationary platen 2. As a result, when the movable mold is moved after molding and is released from the stationary mold to remove a molded product (in the mold releasing process), the whole area of the face of the movable mold separates temporarily from the whole area of the face of the stationary mold. A phenomenon that a part of the face of the movable mold is separated from

a part of the face of the stationary mold while ther parts of the face of the movable mold remain in contact with other parts of the face of the stationary mold does not take place. Therefore, a high precision part such as a lens can be molded with high accuracy.

[0028] Further, each of the tie bars 5 is formed with a sensor hole 12 for inserting a sensor 13 for detecting a strain of the tie bar 5 so that the sensor hole 12 has a predetermined depth from one end face (end face on the stationary platen side) of the tie bar 5. FIG. 2 is an explanatory view of a state in which the sensor 13 is inserted in the sensor hole 12 to detect a strain of the tie bar 5.

[0029] The sensor 13 used (for example, a strain sensor produced by Schlaepfer Sensors Ltd. in Switzerland is provided with a strain gage in a rod-like distal end portion 13a. The diameter of the distal end portion 13a provided with the strain gage is increased by turning the proximal end portion to bring the strain gage into close contact with the inner peripheral surface of the hole 12 in the tie bar 5, by which a strain of the tie bar 5 is measured.

[0030] In the toggle type mold clamping mechanism shown in FIG. 1, a mold clamping force is applied to the mold by the ehongation of the tie bars 5. Therefore, the strain of the tie bar 5 is measured by using the sensor 13, and the position of the rear platen 3 is adjusted so that a preset mold clamping force is provided. In this case, if the strains of the tie bars 5 are equal (under a condition that the materials and diameters of the tie bars 5 are equal), it can be thought that an approximately equal mold damping force is applied to the whole face of the mold. If the strains of the tie bars 5 are not equal, it can be thought that an eccentric mold damping force develops.

[0031] Thereupon, as described above, the sensor 13 is mounted successively in the sensor hole 12 in each of the tie bars 5, the mold is clamped, and the strain is detected successively. Alternatively, the sensors 13 are mounted in the sensor holes 12 in the tie bars 5 at the same time, the mold is clamped, and the strains are measured at the same time. Thereby, the effective lengths of the tie bars 5 are adjusted so that the strains measured on the tie bars 5 are equal and the preset mold clamping force is provided

[0032] In this adjustment, a mold thickness adjusting motor is driven to turn the nuts 8 of the tie bars 5 synchronously via the chain and the pinions 9, so that the rear platen 3 is moved to change a distance between the rear platen 3 and the stationary platen 2, by which the effective lengths of the tie bars 5 for developing a mold clamping force are adjusted. Further, in order to adjust the strains of the tie bars 5 and to balance the mold clamping force developing from each of the tie bars 5, the nut 9 of each of the tie bars 5 is turned individually to adjust the effective length of individual tie bar 5.

[0033] Although the toggle type mold clamping mechanism has been described by way of example in the above-described embodiment, the present invention can be applied to a direct type mold clamping mechanism in which the moving platen is directly driven by the driving source such as a hydraulic cylinder or a servomotor without the use of the toggle mechanism.

Claims

1. A mold clamping mechanism of a molding machine, comprising:

   a stationary platen fixed on a base frame of said molding machine;
   a plurality of tie bars one end of which is fixed to said stationary platen; and
   a moving platen formed with a plurality of tie bar penetrating holes, each of said tie bars passing through each of said tie bar penetrating holes;
   said moving platen which has a movable mold attached to one face thereof being moved along said tie bars so as to move toward or away from said stationary platen which has a stationary mold attached to one face thereof, thereby performing mold clamping or mold releasing, wherein
   a ball spline nut is provided in the tie bar penetrating hole in said moving platen, and at least a portion engaging with said moving platen of said tie bar is made a ball spline shaft.

2. The mold clamping mechanism of a molding machine according to claim 1, wherein a sensor bole for inserting a sensor for detecting an axial strain of said tie bar is formed in each of said tie bars in the axial direction from the end face central portion of said tie bar.

3. The mold clamping mechanism of a molding machine accoding to claim 1 or 2, wherein the number of said tie bars is four, and two or more of said ball spline nuts are provided in each of said tie bar penetrating holes in said moving platen.

4. The mold clamping mechanism of a molding machine according to any preceding claim, wherein said molding machine is an injection molding machine.

5. The mold clamping mechanism of a molding machine according to any preceding claim, wherein said moving platen is moved along said tie bars by driving a toggle mechanism.

FIG. 1

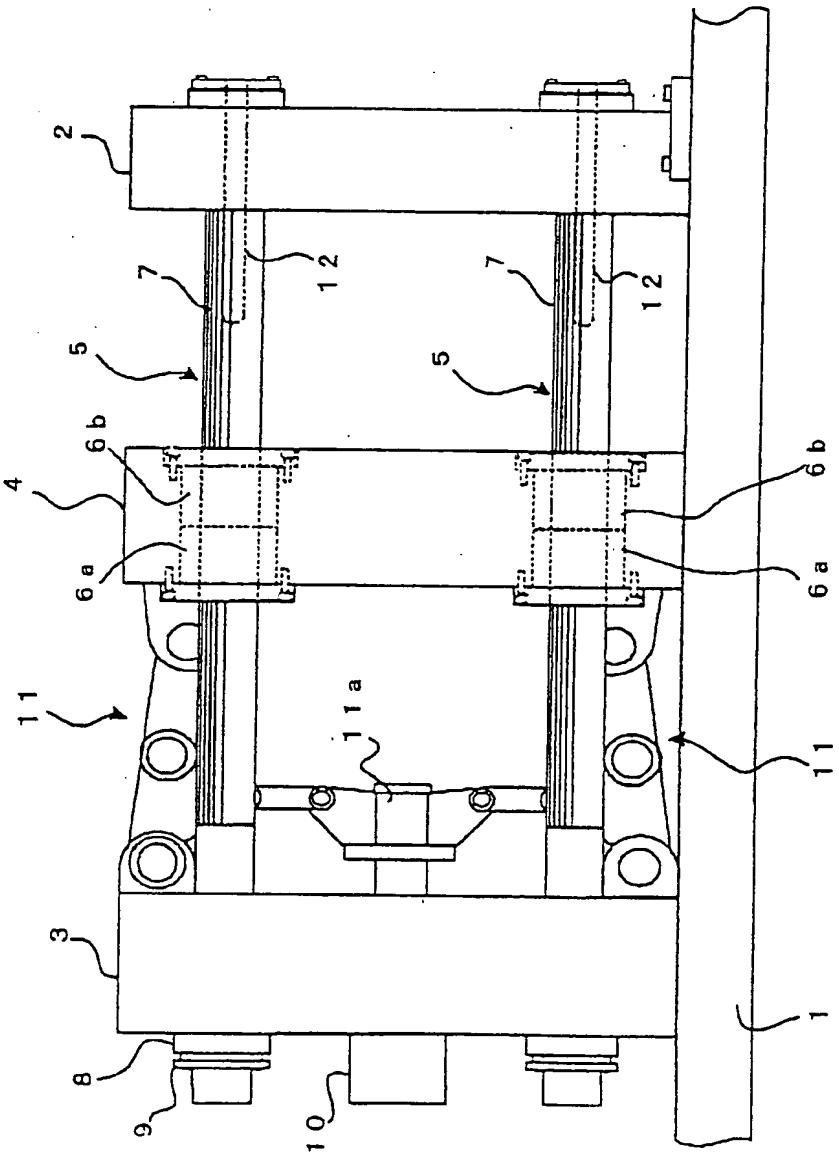


FIG. 2

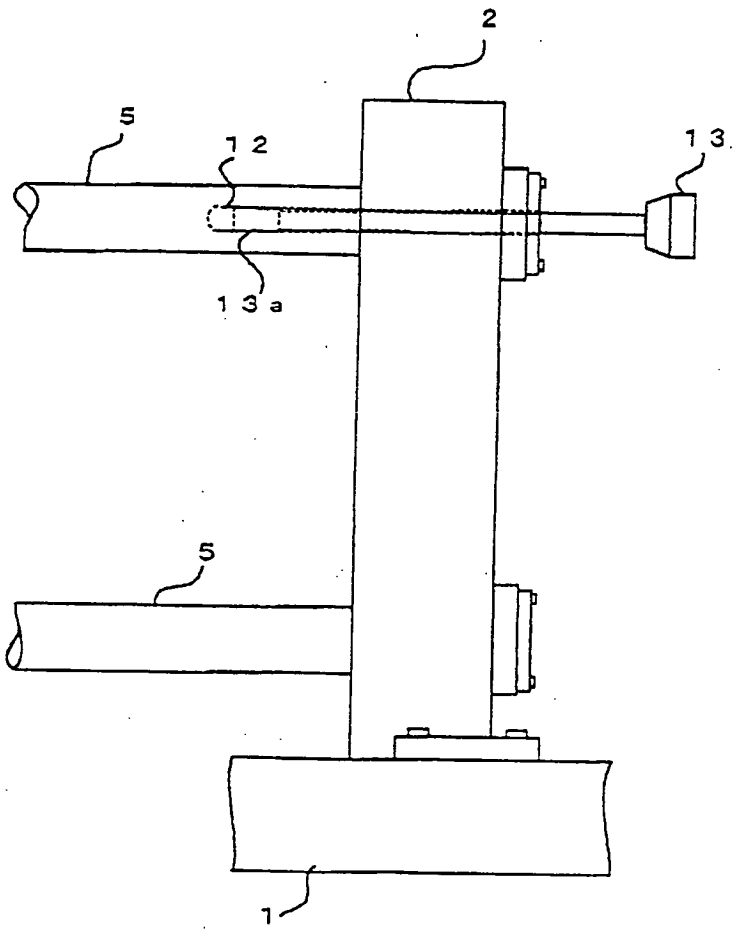
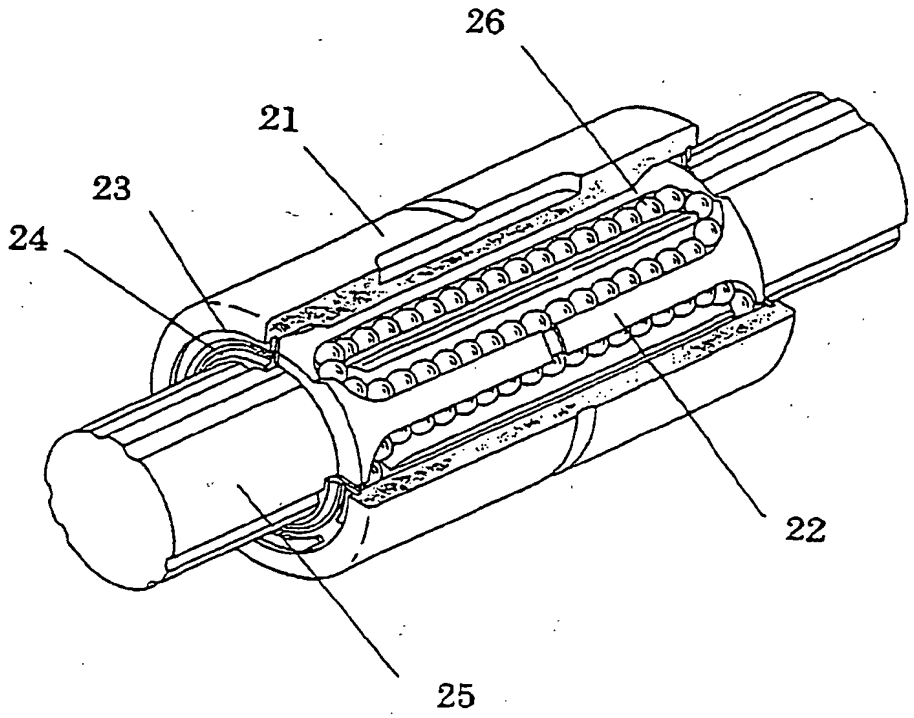


FIG.3



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 136 220 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
29.05.2002 Bulletin 2002/22

(43) Date of publication A2:
26.09.2001 Bulletin 2001/39

(21) Application number: **01302395.7**

(22) Date of filing: **15.03.2001**

(51) Int Cl.[7]: **B29C 45/17**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **16.03.2000 JP 2000073498**

(71) Applicant: **FANUC LTD.**
Minamitsuru-gun, Yamanashi 401-05 (JP)

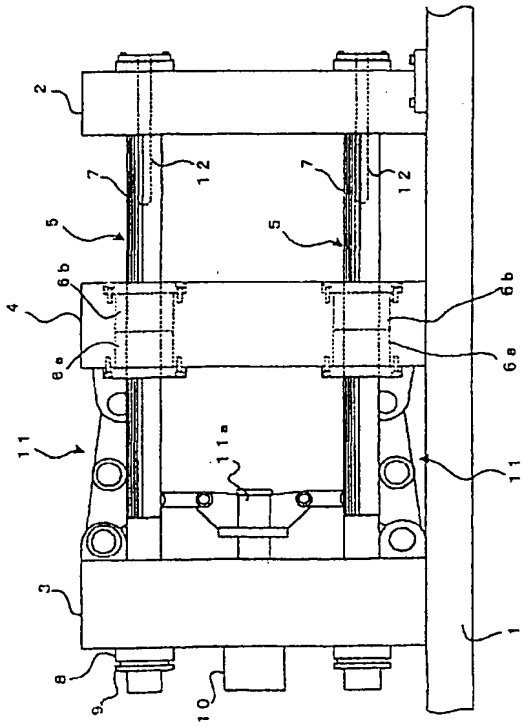
(72) Inventors:
- **Ito, Susumu**
  Hino-shi, Tokyo 191-0065 (JP)
- **Nishimura, Koichi**
  Susono-shi, Shizuoka 401-1115 (JP)

(74) Representative: **Billington, Lawrence Emlyn et al**
Haseltine Lake & Co.,
Imperial House,
15-19 Kingsway
London WC2B 6UD (GB)

(54) Mold clamping mechanism of molding machine

(57) A ball spline nut (6a,6b) is provided in each of tie bar penetrating holes formed in a moving platen (4) constituting a mold clamping mechanism of an injection molding machine. On the other hand, a portion of a tie bar (5) one end of which is fixed to a stationary platen (2), engaging with the tie bar penetrating hole in the moving platen (4), is made a ball spline shaft (7). Since there is no clearance between the ball spline shaft (7) and the ball spline nut (6a,6b) engaging therewith, in mold clamping and mold releasing processes, the posture of a movable mold attached to the moving platen (4) with respect to a stationary mold attached to the stationary platen is always kept constant.

FIG. 1



EP 1 136 220 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 2395

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 18, no. 628 (M-1713), 30 November 1994 (1994-11-30) -& JP 06 241228 A (ENOMOTO:KK), 30 August 1994 (1994-08-30)	1,4	B29C45/17
Y	* paragraph 0001; figures 1,2 * * abstract *	2,5	
X	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 9, 31 October 1995 (1995-10-31) -& JP 07 156232 A (ENOMOTO:KK), 20 June 1995 (1995-06-20) * abstract *	1,4	
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 2, 29 February 1996 (1996-02-29) -& JP 07 285154 A (NIIGATA ENG CO LTD), 31 October 1995 (1995-10-31)	1	
Y	* abstract *	5	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Y	US 4 429 579 A (WILHELM DONALD F) 7 February 1984 (1984-02-07) * the whole document *	2	B29C
Y	FR 1 267 546 A (VEREINIGTE WERKZEUGMASCHINENFABRIKEN AG) 24 November 1961 (1961-11-24) * the whole document *	2	
Y	FR 2 496 548 A (LUDWIG ENGEL KG) 25 June 1982 (1982-06-25) * the whole document *	2	

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 June 2001	BOLLEN, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 2395

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 5, 30 April 1998 (1998-04-30) -& JP 10 026135 A (THK KK), 27 January 1998 (1998-01-27) * abstract * ---	1	
A	US 4 732 489 A (TANAKA KAZUHIKO) 22 March 1988 (1988-03-22) * the whole document * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 June 2001	BOLLEN, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 30 2395

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-06-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 06241228 A	30-08-1994	NONE	
JP 07156232 A	20-06-1995	NONE	
JP 07285154 A	31-10-1995	JP 2792431 B2	03-09-1998
US 4429579 A	07-02-1984	NONE	
FR 1267546 A	21-07-1961	NONE	
FR 2496548 A	25-06-1982	DE 8034172 U1	27-05-1981
		FR 2496548 A1	25-06-1982
		GB 2093759 A ,B	08-09-1982
		IT 1169288 B	27-05-1987
		SE 8107615 A	23-06-1982
JP 10026135 A	27-01-1998	NONE	
US 4732489 A	22-03-1988	JP 1823893 C	10-02-1994
		JP 5026044 B	14-04-1993
		JP 62237113 A	17-10-1987
		DE 3639544 A1	15-10-1987

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82